

Brief Communication

The Flame Effect on Benzo[a]pyrene in Cigarette Smoke

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INTRODUCTION

We report here for the first time an observation that the benzo[a]pyrene (BaP) levels in mainstream cigarette smoke are dependent on the type of flame used to light the cigarette. This flame effect could be significant in that it may double the BaP delivery of the whole cigarette when a yellow flame device is used to light a cigarette compared to a non-flame or blue flame lighting device. The quantity of BaP contributed by the lighting puff using a yellow flame can equal the amount generated from the tobacco of the entire cigarette.

Numerous workers [1–7] have observed polycyclic aromatic hydrocarbons (PAHs) in tobacco smoke. Over 300 of these compounds, many of them methylated, have been identified. The studies have concentrated on PAH formation from various tobacco types and tobacco constituents including sugars, cellulose, terpenes, and paraffins. Although early studies found no association between lung cancer incidence and the use of organic solvent-charged lighters by smokers [8, 9], interest continued in the putative inhalation of fumes from petrol lighters [10, 11]. Marienfeld demonstrated that various types of matches and wick type cigarette lighters form considerable quantities of soot which contain BaP [11]. Marienfeld's concern was that smokers might directly inhale the fumes and soot from the lighting flame through their noses. Here we report an observation that depending on the type of flame used to light the cigarette, the mainstream smoke can contain quite different levels of BaP.

EXPERIMENTAL

Four lighting devices were used to light the cigarettes in this study: an electric lighter, a butane torch lighter, a conventional butane lighter and paper book safety matches. The butane torch lighter, designed to increase combustion efficiency, burns with a pale blue flame. The flame of the conventional butane lighter is pale blue at its base and bright yellow at the tip. The match flame is shorter in height and is predominantly yellow. The blue portion is small and generally surrounds the burning matchstick.

Two types of cigarettes were used in this study. One is the 1R4F Kentucky Reference cigarette developed for research purposes by the National Cancer Institute of the National Institute of Health, the Agricultural Research Service of the United States Department of Agriculture, and the Tobacco and Health Research Institute of the University of Kentucky [12]. The other, designated as IM16, is an industrial monitor cigarette designed by Philip Morris. The 1R4F and IM16 differ both in tobacco blend and filter ventilation. The IM16 is not ventilated while the 1R4F is 28% ventilated.

During lighting, the end of the cigarette rod was kept in contact with the heat source for the duration of the lighting puff. The electric lighter was positioned about 2 mm from the tip of the cigarette without touching it. With the yellow flame devices the cigarette tip was positioned in various parts of the flame. All cigarettes were smoked under the standard machine smoking procedures proposed by International Organization for Standardization (ISO) using 35 cc puff volume of 2-s duration taken at 60-s intervals [13]. Under these conditions, the puff counts are approximately nine and eight for the 1R4F and IM 16 cigarettes, respectively. The

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